

# Active Site Engineering in Porous Electrocatalysts

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## Abstract

Electrocatalysis is at the center of many sustainable energy conversion technologies that are being developed to reduce the dependence on fossil fuels. The past decade has witnessed significant progresses in the exploitation of advanced electrocatalysts for diverse electrochemical reactions involved in electrolyzers and fuel cells, such as the hydrogen evolution reaction (HER), the oxygen reduction reaction (ORR), the CO<sub>2</sub> reduction reaction (CO<sub>2</sub>RR), the nitrogen reduction reaction (NRR), and the oxygen evolution reaction (OER). Herein, the recent research advances made in porous electrocatalysts for these five important reactions are reviewed. In the discussions, an attempt is made to highlight the advantages of porous electrocatalysts in multiobjective optimization of surface active sites including not only their density and accessibility but also their intrinsic activity. First, the current knowledge about electrocatalytic active sites is briefly summarized. Then, the electrocatalytic mechanisms of the five above-mentioned reactions (HER, ORR, CO<sub>2</sub>RR, NRR, and OER), the current challenges faced by these reactions, and the recent efforts to meet these challenges using porous electrocatalysts are examined. Finally, the future research directions on porous electrocatalysts including synthetic strategies leading to these materials, insights into their active sites, and the standardized tests and the performance requirements involved are discussed.